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Fishing Performance of Rectangular and Conical Sablefish Traps off Southeastern Alaska

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ABSTRACT

Rectangular and conical sablefish traps were fished concurrently in southeastern Alaska waters to compare the catches and ease of handling of the two gear types. The numbers and sizes of sablefish, *Anoplopoma fimbria*, caught in each trap type were similar as were catches of incidental species. Conical traps were superior to rectangular traps in handling and workability at sea and are recommended for future Sablefish Index Surveys conducted by the National Marine Fisheries Service.

CONTENTS

INTRODUCTION

Sablefish, *Anoplopoma fimbria*, are an important groundfish resource of the Gulf of Alaska, and a U.S. fishery for sablefish off southeastern Alaska has existed since early this century. In recent years, the U.S. catch of sablefish has usually ranked second (after Pacific halibut, *Hippoglossus stenolepis*) in both landings and economic value among all groundfish species in the Gulf of Alaska.[1] Foreign nations, particularly Japan, have also caught large quantities of sablefish in the Gulf of Alaska, and annual foreign catches average over 6,000 metric tons for the years 1978-1982 (Stauffer 1983)., The annual Japanese catch alone has exceeded the annual U.S. catch each year since 1963.

Since 1978, the National Marine Fisheries Service (NMFS) has conducted an annual sablefish survey off southeastern Alaska, where the U.S. fishery is concentrated. The survey provides yearly indices of relative abundance at specific sites and depths along the outer coast for use in management of the fishery (Zenger 1981). -Although longlines are the predominant gear type in the fishery, baited traps were chosen as the gear for the survey because trap fishing effort can be more accurately standardized.

The traps used in the survey are rectangular and can be collapsed and stored on deck. This style of trap was designed about 1970 specifically for capturing sablefish (High 1971) and soon became an important gear in sablefish fisheries off the Canadian and U.S. west

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1 J. Smoker, Program Leader of the Alaskan field office for the National Marine Fisheries Service's National Fishery Statistics Program, Juneau, Alaska, pers. commun. March 1984.

coasts. However, the traps are bulky and difficult to handle, and assembling and collapsing them at sea is time consuming.

In the late 1970's a conical-shaped sablefish trap, sometimes called a "Korean" or "Japanese" trap, was developed that many commercial fisherman claimed was better than the rectangular trap. The conical traps are smaller and lighter than rectangular traps, they do not have to be assembled and collapsed, and more traps can be stacked on the deck of a vessel.

Fishermen reported good catches of sablefish in the conical traps. By 1979, almost all sablefish trap fishermen in Canada were using the conical traps (Stocker 1981), as were U.S. fishermen in Washington and Oregon.

In 1983, we conducted an extensive experiment in southeastern Alaska waters' to compare catch and efficiency of rectangular and conical sablefish traps. The objective of our study was to evaluate the relative merits of rectangular versus conical traps as a gear type for the NMFS sablefish index surveys. We wanted to determine whether estimates of abundance of sablefish would have the same precision for both types of traps and whether conical traps could be more easily and efficiently handled than rectangular traps. This report compares rectangular and conical traps in terms of 1) catch rates for sablefish, 2) size of sablefish caught, 3) incidental species (i.e., species other than sablefish) caught, and 4) ease of handling and workability at sea.

METHODS

The design of the rectangular traps used in the study is described by Hipkins (1974). The trap frame was constructed of welded steel rods, and when assembled, the trap's dimensions were 0.86 m X 0.86 m X 2.44 m (34 in. X 34 in. X 8 ft; Fig. 1). The trap lies flat when collapsed. The frame was covered by 8.9-cm (3.5-in.) stretched-mesh nylon netting, and a tunnel, also of 8.9-cm (3.5-in.) stretched-mesh nylon netting, was located at one end of the trap to allow entry of fish. The tunnel was 0.75 m (29.5 in.) long, 0.86 m (34 in.) wide at the entrance and 0.41 m (16 in.) wide at the inside end. Each trap weighed approximately 44 kg (96 lb).

The conical traps used in the study were designed in the shape of a truncated cone (Fig. 1) with the frame constructed of welded steel rings and rods. Diameter of the bottom ring was 1.37 m (54 in.), diameter of the top ring was 0.85 m (33.5 in.), and the height was 0.71 m (28 in.). The frame was covered by 7.6-cm (3-in.) nylon stretched-mesh netting, and a tunnel of 5.1-cm (Z-in.) nylon stretched-mesh netting was located on the side of the trap. The tunnel was 0.74 m (29 in.) long, 0.52 m (20.5 in.) wide at the entrance and 0.46 m (18 in.) wide at the end. Each trap weighed approximately 25 kg (55 lb).

We fished both types of traps in two areas of southeastern Alaska: in the sheltered waters of Lynn Canal and along the outer coast in the Gulf of Alaska. Three sites were fished in Lynn Canal, and four sites in the Gulf of Alaska (Fig. 2, Table 1). The Lynn Canal sites were fished first as an initial comparative test of rectangular and conical traps. Subsequently, the Gulf of Alaska sites were fished during the annual Sablefish Index Survey for a direct comparison of performance on the survey grounds. Sample size in terms of number of traps fished was much larger in the Gulf of Alaska area, where 77 strings of traps were

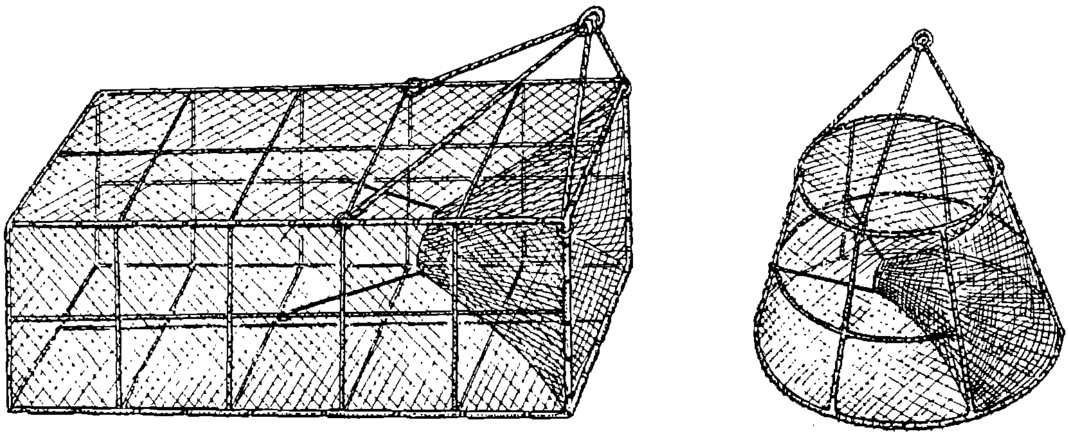

Figure 1.--Two types of sablefish traps fished in our study.

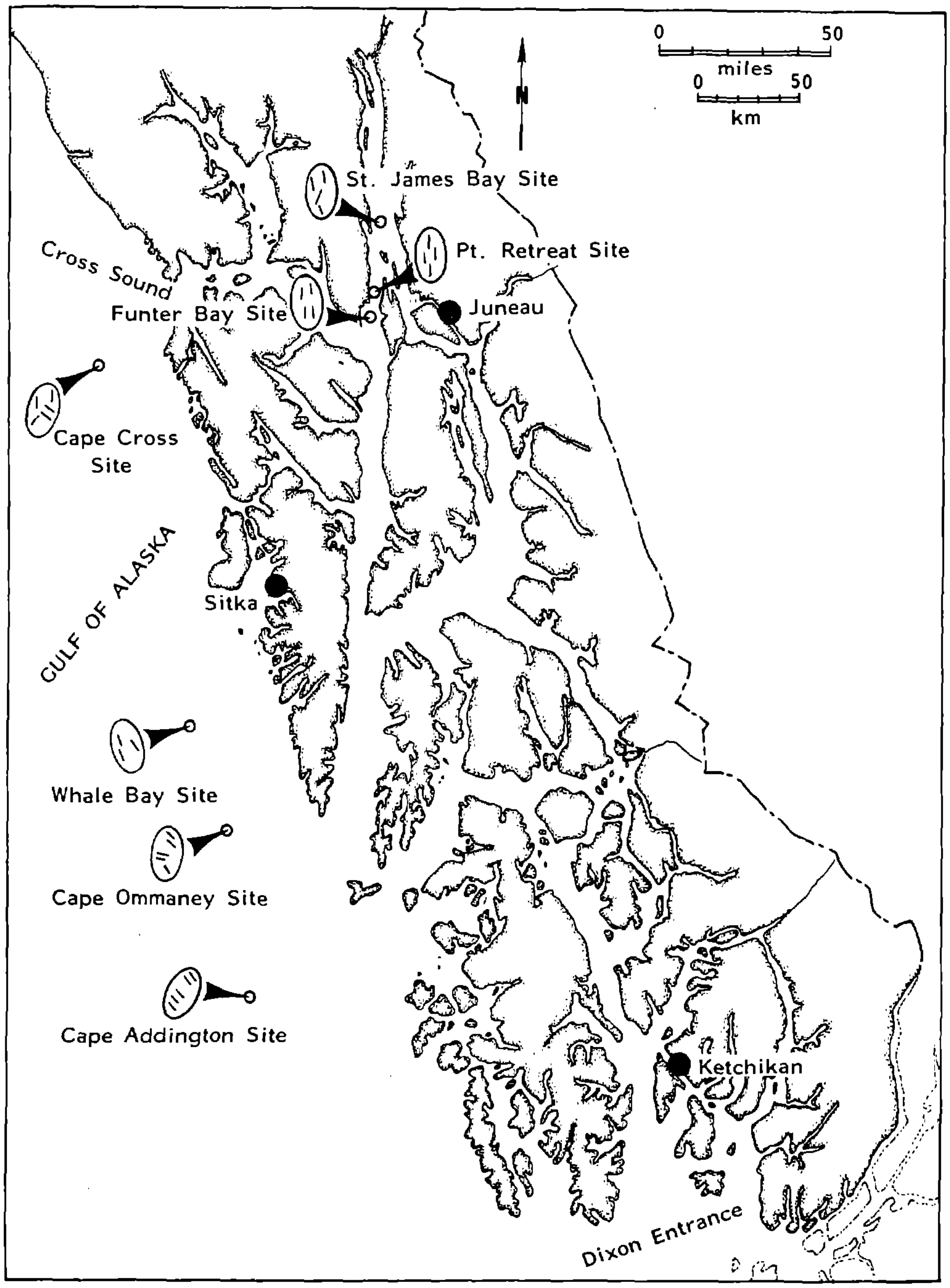

Figure 2.--Locations fished using rectangular and conical sablefish traps, southeastern Alaska waters, 1983. Each dash represents the location of one string of five rectangular and five conical sablefish traps.

Table 1--Summary of information on sites where fishing comparisons were made between rectangular and conical sablefish traps, southeastern Alaska waters, 1983. Each string of traps consisted of five rectangular and five conical traps.

Site	Dates fished	Depths fished (m)	No. strings of traps fished	No. sablefish caught per trap
Lynn Canal Area				
Pt. Retreat	April 1983	490-618	9	4.77
St. James Bay	April 1983	287-375	6	0.33
Funter Bay	April 1983	599-669	7	6.11
		Total	22	
Gulf of Alaska Area				
Cape Addington	May 1983	282-856	15	3.66
Cape Ommaney	June 1983	258-858	25	1.56
Whale Bay	June 1983	271-594	9	1.10
Cape Cross	June 1983	258-832	28	1.47
		Total	77	--

fished, than in the Lynn Canal area, where only 22 strings were fished.

To determine whether abundance of fish affected the catch of one trap type relative to the other type, we selected the localities to include sites where sablefish were abundant (see Table 1: Pt. Retreat, Funter Bay, and Cape Addington) and sites where sablefish were comparatively scarce (St. James Bay, Cape Ommaney, Whale Bay, and Cape Cross).

At each site, three to five strings of baited traps were fished on the bottom each day. A string consisted of 10 traps (5 rectangular and 5 conical traps) spaced equidistantly along a 1,006-m (550-fathom) groundline; thus, 30-50 traps (15-25 of each type) were fished per day (see Hipkins (1974) for details on groundline design). Each trap was baited with about 0.9 kg (2 lb) of chopped Pacific herring, Clupea harengus pallasi, in a perforated plastic jar. At the Gulf of Alaska sites, rectangular and conical traps were alternated along the groundline in each string, in the sequence C-R-C-R-C-R-C-R-C-R, where C denotes a conical trap and E a rectangular trap. At the Lynn Canal sites, the sequence of traps in a string was slightly different: C-R-R-C-C-R-R-C-C-R. This latter arrangement of traps was necessary to accommodate our gear comparison study with another experiment being conducted simultaneously.

Each string of traps was fished for 24 h. The strings were usually set in the morning or early afternoon and hauled 24 h later. The traps were closed with a timed-release device that standardized fishing time to 24 h in case the strings could not be retrieved because of stormy weather. The device, a magnesium-alloy link, corrodes and breaks after 24 h and closes the entry tunnel of the trap (see Zenger

1981). In Lynn Canal, the conical traps did not have closing devices because the calm, sheltered waters there allowed us to haul each string every 24 h.

When the strings were hauled, numbers of sablefish and other species caught were recorded for each trap type. Also, fork lengths of sablefish were measured to the nearest centimeter for both rectangular and conical traps.

We used a ratio estimator (Cochran 1963) to compare catch rates of sablefish in the two trap types. The ratio estimator is described as:

$$\hat{R} = \frac{\sum_{i=1}^{n} Y_i}{\sum_{i=1}^{n} X_i},$$

where

R = the ratio estimator of the underlying true ratio R,

Y_j = the total catch of sablefish in conical traps in string i,

X_i = the catch of sablefish in rectangular traps in string 1, and

n = the total number of strings.

The estimator thus represents pooled data from all strings of traps, and is an estimate of the fishing power for sablefish of conical traps relative to rectangular traps. The ratio estimator is also the maximum likelihood estimator for R, where the joint catches Y_i and E_i in a string can be considered as Poisson random variables. The expected values of v_i and X_i, x . and vary from string to string, depending upon factors such as specific location of the string and time, but are assumed to remain in a constant ratio to each other, i.e.,

$$\lambda_{yi}/\lambda_{xi} = \underline{R}.$$

An estimate of the variance of R was also calculated, using the formula:

$$\mathrm{Var}(\hat{R}) = \frac{1}{n\bar{x}^2} \cdot \frac{\sum_{i=1}^{n} Y_i - \hat{R}X_i{}^2}{n-1},$$

with the same notation as above (see Cochran (1963) for derivation; modified for our study). An estimate of the 95% confidence interval of $\underline{R}$ was then calculated using the computed variance. Ratio estimators, estimates of variance, and confidence intervals were computed separately for both the Lynn Canal and Gulf of Alaska areas.

We also used ratio estimators to determine whether the catch of sablefish differed significantly between rectangular and conical traps by site, abundance of sablefish, or depth. Separate values of R were calculated for each site based on pooled data from all strings of traps fished at a site. To compare catches in each gear when abundance of sablefish was high or low, we pooled catches for the three sites where sablefish were abundant and for the four sites where sablefish were scarce. A ratio estimator was then calculated for each group of sites. For the analysis by depth, we pooled catches from three sites in the Gulf of Alaska (Cape Addington, Cape Ommaney, and Cape Cross) where strings of traps were fished at five discrete depths: ~274 m (150 fathoms), ~412 m (225 fathoms), ~549 m (300 fathoms), ~686 m (375 fathoms), and ~823 m (450 fathoms). Ratio estimators were computed for each depth based on the combined data from the three sites. Catches were not analyzed by depth at the other sites because discrete depths were not fished.

We used two techniques to compare the size of sablefish captured by each gear type: 1) Visual comparisons of graphs of the length-frequency distributions and 2) paired t-tests of mean lengths. Sizes of sablefish in each trap type were compared separately for the Lynn Canal and Gulf of Alaska areas. For the paired t-tests, the mean length of sablefish captured by each gear type was calculated for each string, and the two mean lengths per string made up a paired observation.

The catch of incidental species in rectangular and conical traps was also compared both for Lynn Canal and the Gulf of Alaska. For each area, the total numbers of incidental fish and shellfish caught by each gear were compared with those caught by the other gear and the total number of sablefish caught.

RESULTS AND DISCUSSION

The catches of sablefish in one trap type relative to the other type had considerable variation among individual strings (Figs. 3 and 4). Neither rectangular nor conical traps caught consistently more sablefish. Even at the same depth and location, rectangular traps in a string might catch more sablefish one day, and conical traps in a string might catch more sablefish another day.

When catches from strings at all sites in an area were combined, catches of sablefish did not differ significantly between rectangular and conical traps in the Gulf of Alaska area, but this lack of

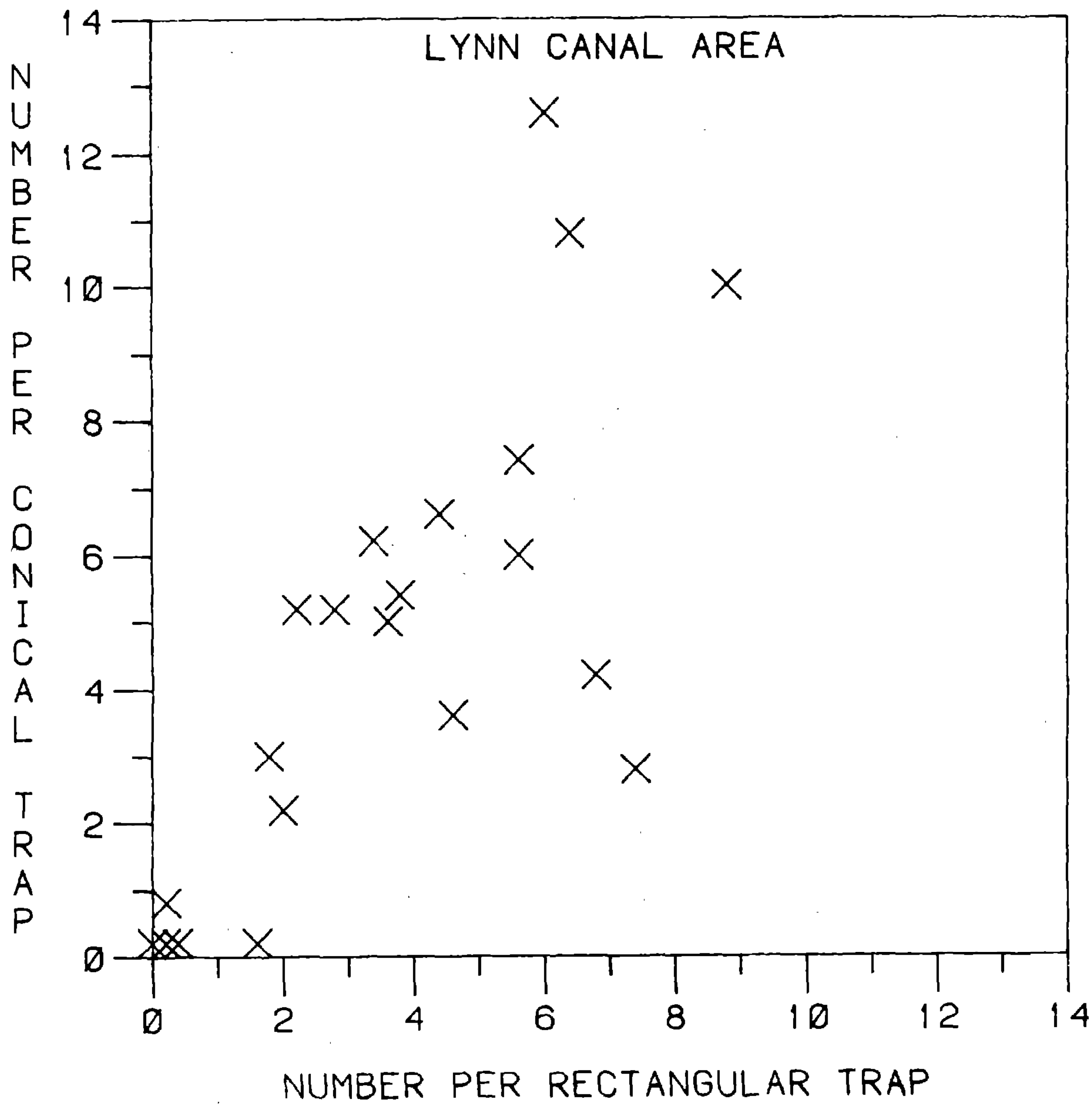

Figure 3.--Catch of sablefish in conical traps vs. catch of sablefish in rectangular traps, Lynn Canal, southeastern Alaska waters, 1983. Each data point represents the catch of a string of 10 traps (5 conical and 5 rectangular traps).

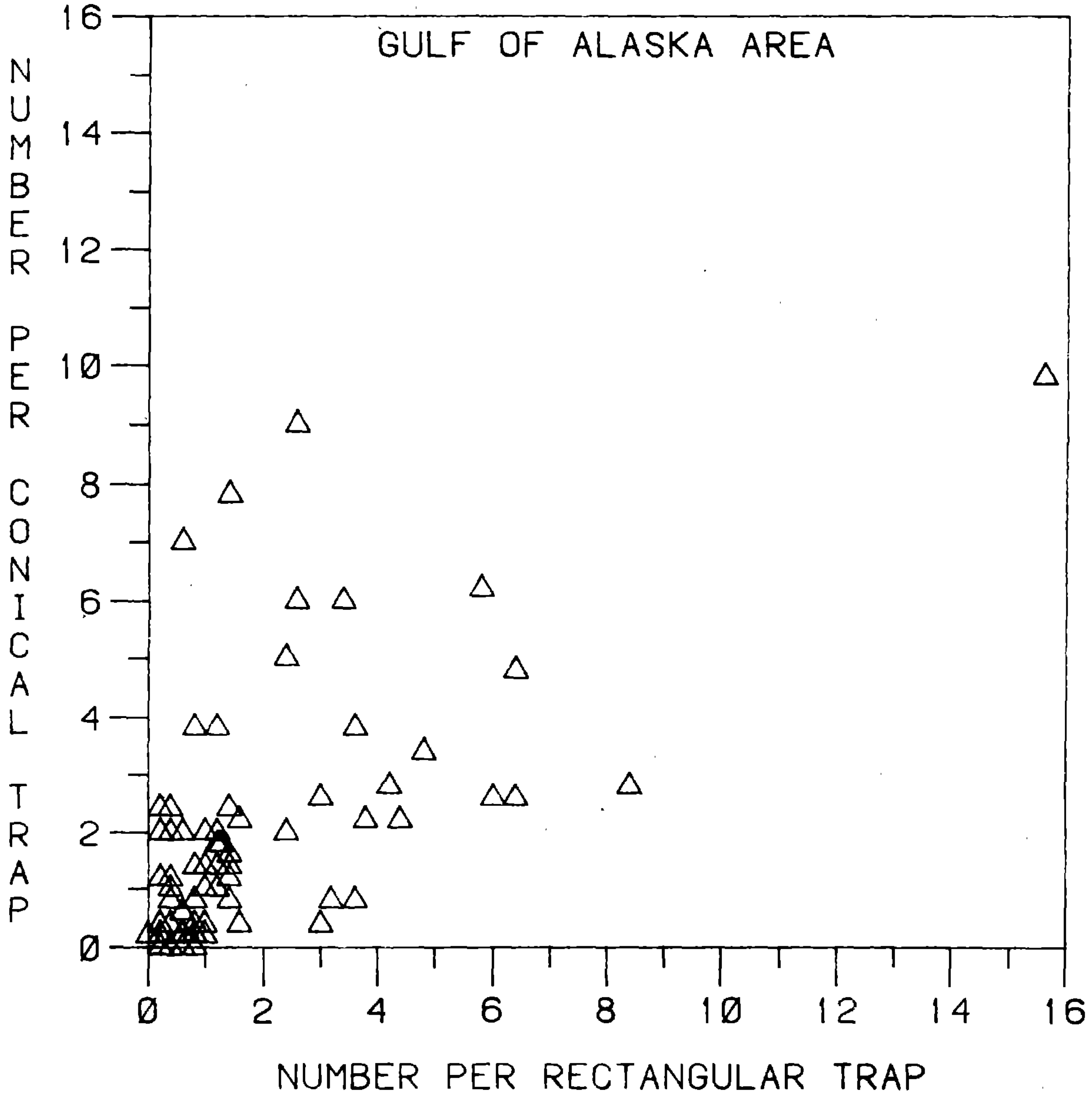

Figure 4.--Catch of sablefish in conical traps vs. catch of sablefish in rectangular traps, Gulf of Alaska, southeastern Alaska waters, 1983. Each data point represents the catch of a string of 10 traps (5 conical and 5 rectangular traps),

significant difference was borderline in Lynn Canal. The R (ratio estimator) values of 1.26 in Lynn Canal and 1.09 in the Gulf of Alaska show that conical traps in both areas caught slightly more sablefish than rectangular traps (Table 2). In the Gulf of Alaska, the small difference in catches between the two gear types was not statistically significant because the 1.0 value (where catch of sablefish in conical traps equals catch of sablefish in rectangular traps) lies well within the 95% confidence interval of R. In Lynn Canal, however, the 1.0 value barely lies within the 95% confidence interval of R and indicates some uncertainty as to whether the catches of conical traps were greater than those of rectangular traps.

At most sites, catches of sablefish in the different traps were not significantly different, although the R values have a wider range and larger variances than those for the two areas (Table 2). This greater variability at sites could be expected, given the smaller sample sizes at each site. Confidence intervals of R for six of the seven sites, however, include the 1.0 value, and indicate no significant difference in catch rates of one gear type 'relative to the other. For the remaining site, Pt. Retreat in Lynn Canal, 1.0 falls below the confidence interval; thus, conical traps caught significantly more sablefish there than rectangular traps did.

The significant difference at Pt. Retreat could be fortuitous rather than real. If the true ratio of the catches is 1.0 (a reasonable assumption based on the previous analysis for the other sites) and seven independent 95% confidence intervals are computed, there is >30% chance that one or more will not contain the 1.0 value.

Table 2.--Ratio estimators used to compare catch of sablefish in conical and rectangular traps, and associated confidence intervals, southeastern Alaska waters, 1983. n = number of strings of traps fished, $\hat{R}$ = computed ratio estimator (number of sablefish caught in conical traps divided by the number of sablefish caught in rectangular traps); Var ($\hat{R}$) = variance of $\hat{R}$.

	n	$\hat{R}$	Var ($\hat{R}$)	95% confidence interval of R
Areas (sites combined):				
Lynn Canal	22	1.26	0.02	$0.97 \leq R \leq 1.54$
Gulf of Alaska	77	1.09	0.02	$0.82 \leq R \leq 1.36$
Individual Sites:				
Lynn Canal:				
Pt. Retreat	9	1.44	0.03	$1.11 \leq R \leq 1.77$
St. James Bay	6	0.64	0.18	$0 \leq R \leq 1.48$
Funter Bay	7	1.14	0.05	$0.70 \leq R \leq 1.58$
Gulf of Alaska:				
Cape Addington	15	0.83	0.03	$0.51 \leq R \leq 1.15$
Cape Ommaney	25	1.35	0.13	$0.64 \leq R \leq 2.07$
Whale Bay	9	1.63	0.23	$0.69 \leq R \leq 2.58$
Cape Cross	28	1.17	0.05	$0.73 \leq R \leq 1.61$
Sites grouped by relative abundance of sablefish:				
High abundance[1]	31	1.08	0.02	$0.84 \leq R \leq 1.32$
Low abundance[2]	68	1.27	0.03	$0.91 \leq R \leq 1.63$

Tabl-e 2. --Continued.

	$\underline{n}$	$\hat{\underline{R}}$	Var ($\hat{\underline{R}}$)	95% confidence interval of $\underline{R}$
Depth fished[3]				
~274 m (150 fa)	14	0.89	0.04	$0.51 \leq R \leq 1.28$
~412 m (225 fa)	14	1.49	0.18	$0.67 \leq R \leq 2.31$
~549 m (300 fa)	14	0.93	0.07	$0.41 \leq R \leq 1.44$
~686 m (375 fa)	13	1.02	0.02	$0.75 \leq R \leq 1.29$
~823 m (450 fa)	13	1.38	0.09	$0.78 \leq R \leq 1.98$

1 Data pooled from Pt. Retreat, Funter Bay, and Cape Addington sites.

2 Data pooled from St. James Bay, Cape Ommaney, Whale Bay, and Cape Cross sites.

3 Data pooled from three sites where discrete depths were fished: Cape Addington, Cape Ommaney, and Cape Cross;

Results for the Lynn Canal area (where sites were combined) may be biased for two reasons: 1) The possibly anomalous data at Pt. Retreat and 2) the small total sample size of traps fished in Lynn Canal. The catches at Pt. Retreat unduly affected the R value and confidence interval for Lynn Canal because 9 of the 22 strings fished in Lynn Canal were at the Pt. Retreat site. Thus, the high catch of sablefish at Pt. Retreat in conical traps compared to rectangular traps results in a high catch of sablefish in conical traps in the Lynn Canal area. Results from the Gulf of Alaska area, with 77 strings of traps fished, represent a much better statistical comparison between catches in the two gear types.

Neither relative abundance of sablefish nor depth had a marked effect on catches of one trap type relative to the other type. For groups of sites with high abundance or low abundance of sablefish and for the five depths fished, the confidence intervals of R contain the 1.0 value (Table 2). No trend by depth is shown in the values of R.

We found no differences between rectangular and conical traps in the size of sablefish caught. Sablefish length-frequency distributions were similar for each gear type (Figs. 5 and 6). Paired t-tests showed no significant difference in the lengths of sablefish between the two types of traps in either Lynn Canal or the Gulf of Alaska (for Lynn Canal, df = 20, t = 0.89, P = 0.38; for the Gulf of Alaska, df = 66, t = -0.20, p = 0.84).

Each gear type caught few numbers of incidental species, and the species composition in each was similar. Incidental species made up less than 20% of the total catch in numbers, both in rectangular and

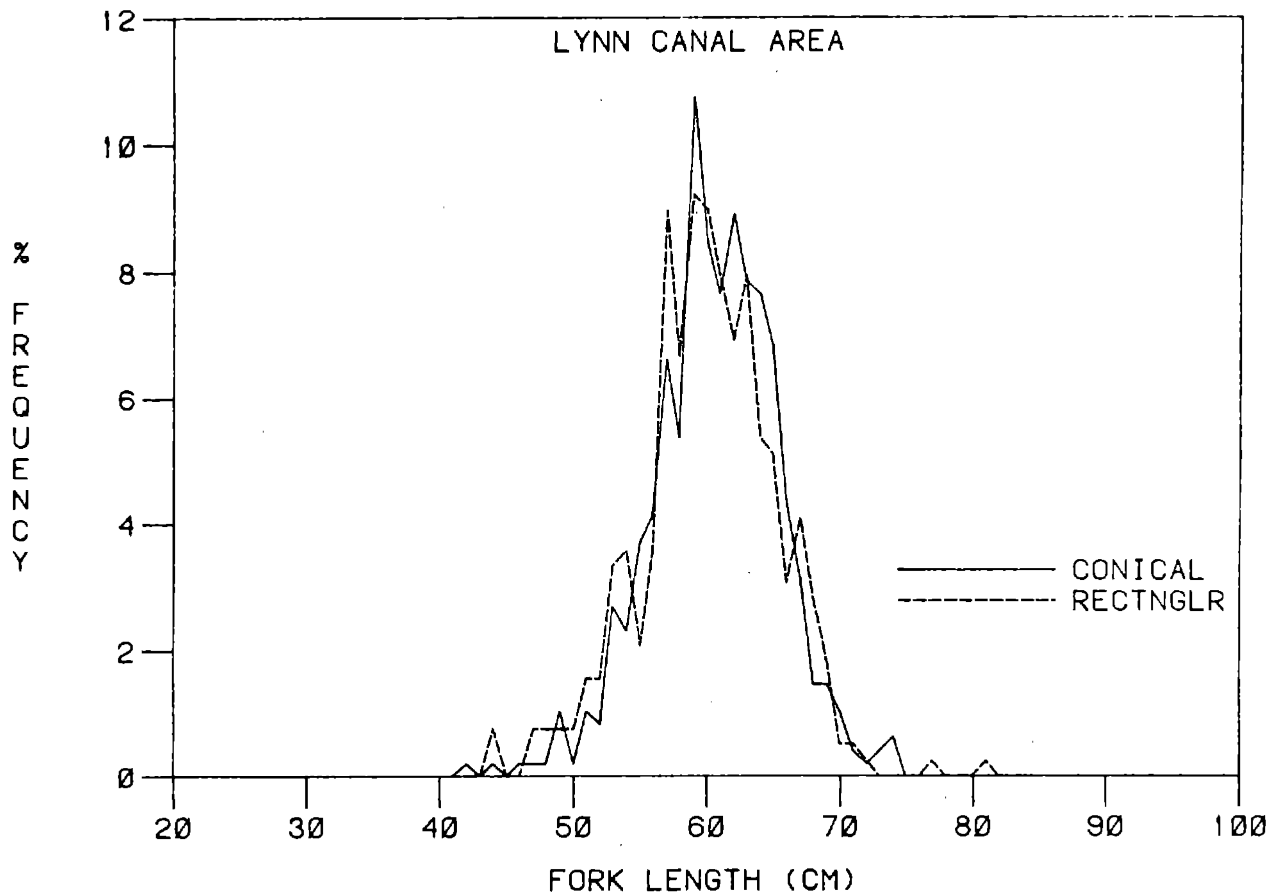

Figure 5.--Length frequency distributions of sablefish in rectangular and conical traps, Lynn Canal, southeastern Alaska waters, 1983. (For rectangular traps, no. of sablefish = 391, x = 60.6 cm; for conical traps, no. of sablefish = 484, x = 58.7 cm).

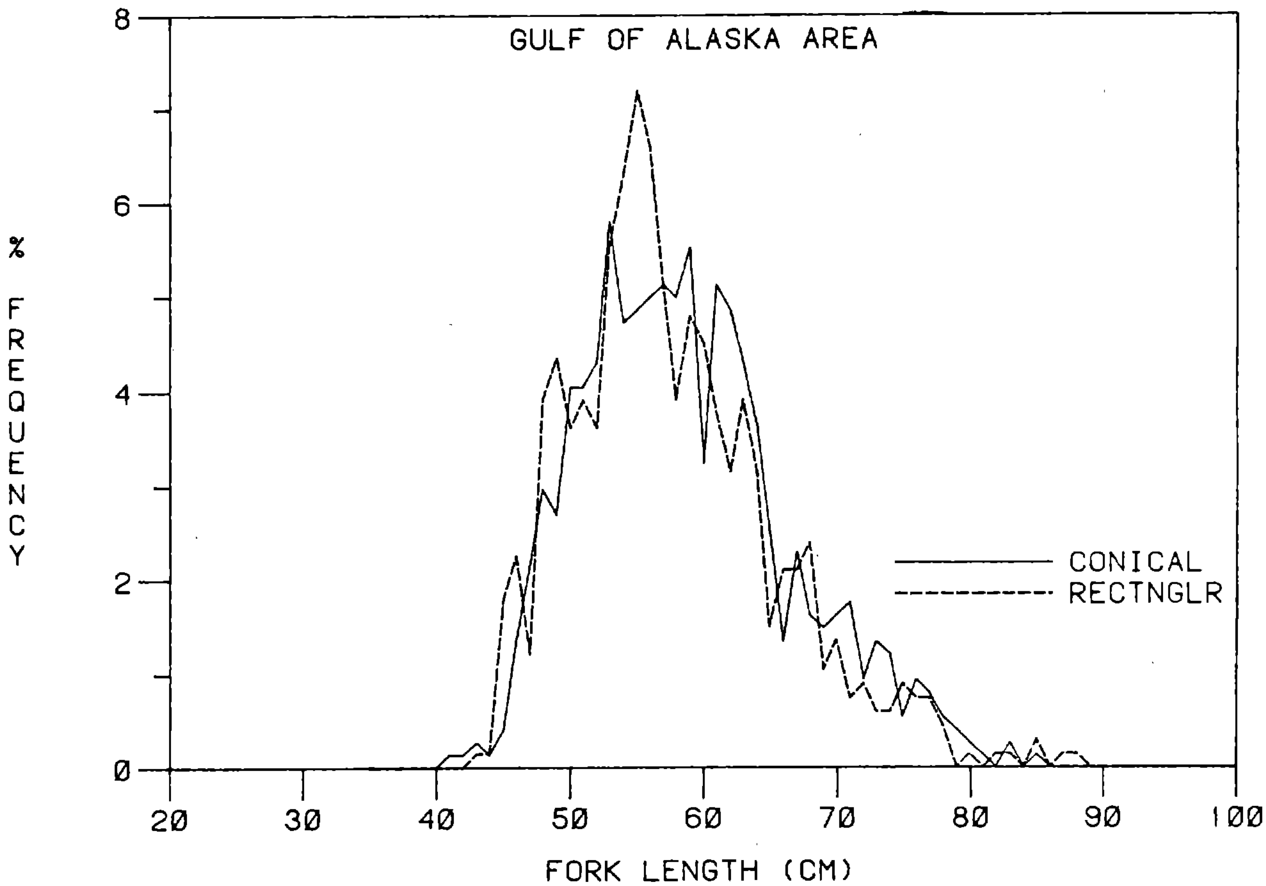

Figure 6.--Length frequency distributions of sablefish in rectangular and conical traps, Gulf of Alaska, southeastern Alaska waters, 1983. (For rectangular traps, no. of sablefish = 667, $\bar{x}$ = 57.8 cm; for conical traps, no. of sablefish = 742, $\bar{x}$ = 58.7 cm).

conical traps (Table 3). For each gear type, golden king crab (*Lithodes aequispina*) and Pacific halibut were the most common incidental species in Lynn Canal, and Tanner crab (*Chionoecetes tanneri*), rockfishes (Scorpaenidae), Dover sole (*Microstomus pacificus*), and Pacific halibut were most common in the Gulf of Alaska.

Table 3.--Percent of incidental fish and sablefish caught in rectangular and conical traps, southeastern Alaska waters, 1983.

	Lynn Canal catches (% by number)		Gulf of Alaska catches (% by number)	
	Rectangular traps	Conical traps	Rectangular traps	Conical traps
Incidental fish	9.3	8.9	18.7	13.7
Sablefish	90.7	91.1	81.3	86.3

We found conical traps to have many practical advantages when compared to rectangular traps. These include:

1) Conical traps are lighter than rectangular traps and can be handled on deck by one person. At least two people are needed to handle the heavier rectangular traps.

2) Conical traps are readily stacked atop one another for storage on deck, whereas the bulkier rectangular traps are difficult to stack.

3) Stacks of conical traps occupy less space and are easier to move than stacks of rectangular traps.

4) Conical traps, because of their rigid design, do not have to be assembled for fishing. Collapsed rectangular traps are assembled

with hooks and rubber bands to hold the traps upright, and thus require extra time for set-up.

5) Conical traps are opened using one drawstring so that the catch can be easily removed and the trap baited. Eight hooks must be removed to open the rectangular traps, making removal of the catch and baiting difficult.

6) There is less tendency for the buoyline or groundline of conical traps to break during hauling because the conical traps are lighter and exert less drag in the water than rectangular traps.

7) A conical trap costs 40-50% less than a rectangular trap.

We found no practical advantages favoring rectangular traps. Thus, conical traps are superior to rectangular traps in ease of handling at sea and reduced costs.

In another study, catches in conical traps were, compared with catches in rectangular traps off California.[2] Our results differ markedly from the results of the California study. In our study, both gear types caught similar numbers of sablefish; in' the California study, rectangular traps caught three times as many sablefish as did conical traps. This difference in results between the two studies can be explained by the different design of conical traps used in the California test. There, an early design of conical trap was fished that weighed less and had a different style of entry tunnel than our conical traps. Apparently, the conical traps in our study were more effective in catching sablefish.

2N. Parks, Northwest and Alaska Fisheries Center, National Marine Fisheries, Service, NOAA, 2725 Montlake Boulevard East, Seattle, WA 98112, 1980 unpubl. data.

CONCLUSIONS

In southeastern Alaska waters, neither rectangular nor conical traps had a decided advantage based on catches alone. We found no significant differences between catches of sablefish in the two gear types, either in numbers or size of fish caught, when the sample size of traps fished was large. Catch of incidental species was also similar in each gear. Thus, if conical traps are used in future sablefish surveys, precision of estimates of relative abundance would be maintained because both gear types sample a similar proportion of the population. Little or no bias would be introduced due to differences in fishing power of rectangular and conical traps, and at this time, there is no conclusive need for conversion factors between the catch rates of the two gear types.

Conical traps, however, have important labor and cost advantages that make them more efficient than rectangular traps in operations at sea. The practical advantages of conical traps, combined with the similarity of their catches compared to rectangular traps, justify the use of conical traps in future Sablefish Index Surveys.

ACKNOWLEDGMENTS

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